Operation Manual

Thorlabs Instrumentation

OEM Laser Diode Controller

ITC1xx

2006

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Contents **Page**

We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to come up to your expectations and develop our products permanently we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. We and our international partners are looking forward to hearing from you.

Thorlabs

This part of the instruction manual contains every specific information on how to operate the OEM laser diode controller module ITC1xx.

☝Attention☝

This manual contains “WARNINGS” and “ATTENTION” label in this form, to indicate dangers for persons or possible damage of equipment.

Please read these advises carefully!

NOTE

This manual also contains “NOTES” and “HINTS” written in this form.

1 General description

1.1 Safety

☝Attention☝

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly

Connecting the OEM board ITC1xx, internal adjustments and re-placement of parts must only be done by qualified service personnel.

It must be sure that the power supply used for the ITC1xx is sepa-rated galvanically from the mains.

The power supply as well as the ITC1xx must be grounded properly.

All connections to and from the ITC1xx must be done with duly shielded connection cables (twisted pairs).

Laser diodes can deliver up to several W of (maybe) invisible laser radiation!

When operated incorrectly, this can cause severe damage to your eyes and health!

Be sure to pay strict attention to the safety recommendations of the appropriate laser safety class!
This laser safety class is marked on your external laser source used.

☝ Attention ☝

Mobile telephones, handy phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to EN 50 082-1.

☝ Attention ☝

The ITC1xx must not be operated in explosion endangered environments!

1.2 Features

The laser controller ITC1xx is a compact combined laser current and temperature controller for OEM applications on a single Euro-board (100 x 160 mm).
A variety of safety measures allows easy and safe operation of semiconductor laser diodes.

- Softstart
- Interlock
- Hardware laser current limit
- Hardware TEC current limit
- Over temperature protection
- Temperature window for the laser diode
- Power supervision

Other features:

- Constant current or constant power mode
- Bipolar operation of laser diodes
- 2 mA floating photo current input
- Modulation input
- Individual TEC controller PID adjustment possible
- Thermistor or AD590/LM335 temperature sensor selectable
- Temperature tune input
- Analog control output for I_{LD}, I_{LIM}, I_{PD}, T_{SET}, T_{ACT}, I_{TLIM}, I_{TEC}

1.3 Technical data

(All technical data are valid at 23 ± 5°C and 45 ±15% humidity)

1.3.1 General data ITC1xx

DC power supply voltage	±11.4 V ... ±15.8 V
DC power supply current (ITC102 / 110 / 133) [1)]	2.3 A / 3.1 A / 3.1 A [2)]
Dimensions (WxHxD)	Euro-board 100 x 42 x 160 mm^3 [1) 3)]
Operating temperature	0 ... +40 °C
Storage temperature	-40 °C ... +70 °C
Warm-up time	≤10 min
Weight	<0.7 kg [2)]

1.3.2 Display ITC100D

Selectable display values:	I_{PD}, I_{LD}, I_{LIM}, T_{SET}, T_{ACT}, I_{TLIM}
Resolution	$3^1/_2$ digits
Basic accuracy	±0.2 % fs
Accuracy with any ITC1xx	typ. ±2 %±0.4 % fs
Accuracy calibrated to ITC1xx[4)]	±0.5 %±0.2 % fs
Power supply (from ITC1xx)	5V±5 % / 200 mA
Dimensions (W x D x H)	70 x 100 x 45 mm
Decimal points set by jumper	
Weight	<0.1 kg

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[1] Without display

[2] The total combined output current for the ITC133 is limited by the total thermal dissipation loss. When the standard heat sink is used, the total output current should be limited to 3A (I_{LD} + I_{TEC} ≤ 3A). Optimized cooling by fan or bigger heat sink allows 3A LD and 3A TEC at the same time provided the power supply provides 6.1A

[3] Length with connectors: 176 mm

[4] See section 3.2 ITC100D (re)-calibration on page 50

1.3.3 ITC102

Current control	
Range of laser current I_{LD}	0 ... ± 200 mA
Compliance voltage	> 4 V
Setting accuracy	± 2% fs typ.
Noise	< 2 µA
Drift (30 min. without changing the ambient temperature)	≤ 20 µA
Temperature coefficient	≤ ± 50 ppm/°C
Current limit	0 ... > 200 mA
Setting accuracy of current limit	± 2% fs typ.
Power control	
Photodiode current	5 µA...2 mA
Setting accuracy	± 2% fs typ.
Analog modulation input (LD MOD)	
Voltage range	-5 ... +5 V
Input impedance	10 kΩ
Modulation coefficient (constant current)	40 mA/V ± 5%
3 dB bandwidth (constant current)	DC...200kHz
Modulation coefficient (constant power)	0.4 mA/V ± 5%
TTL-modulation, rise-time (constant current)	< 10 µs
Control outputs	
Laser diode current (I_{LD}):	
Voltage range	-5 ... +5 V
Min. load resistance	500 kΩ
Output coefficient (f.s.)	25 V/A± 2% typ.
Laser current limit ($I_{LD\ LIM}$):	
Voltage range	0 ... +5 V
Min. load resistance	500 kΩ
Output coefficient (f.s.)	25 V/A± 2% typ.

Photodiode current (I_{PD}):

Voltage range	0 ... +5 V
Min. load resistance	500 kΩ
Output coefficient (f.s.)	2.5 V/mA ± 2% typ.

Temperature control

TEC current I_{TEC}	0... ±2 A
TEC voltage U_{TEC}	>6 V
Max. output power P_{MAX}	12 W
Measurement accuracy (f.s.)	typ. ± 2%
Noise and ripple	<1 mA
Current limit	0...>2 A
Resolution	10 mA with display
Accuracy (f.s.)	± 5% typ.

Temperature sensor

Control range thermistor	0.1...80 kΩ
Resolution	100 Ω with display
Accuracy (f.s.)	± 2% typ.
Stability	2 Ω
Reproducibility	± 0.1%

AD590/LM335

Control range	-20...+80 °C
Resolution	0.1 °C with display
Accuracy	±2 °C typ.
Stability	0.004 °C
Reproducibility	± 0.1°C

Control input (T TUNE)

Voltage range	-5 ... +5 V
Input impedance	10 kΩ
Coefficient with thermistor	16 kΩ/V
Coefficient with AD590	20 °C/V

Temperature window	0.3°C ... ∞ / 0.3 kΩ ... ∞ [1]

Control outputs

Set temperature (T_{SET} / R_{SET}), actual temperature (T_{ACT} / R_{ACT})

Voltage range	-1 ... +4V / +5mV ... +4V [1]
Min. load resistance	500 kΩ
Output coefficient	50 mV/°C / 50 mV/kΩ ± 2% fs typ.[1]

TEC current (I_{TEC})

Voltage range	-5V ... +5 V
Min. load resistance	500 kΩ
Output coefficient	2.5 V/A± 2% fs typ.

TEC current limit ($I_{TEC\ LIM}$)

Voltage range	0 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	2.5 V/A± 2% fs typ.

Difference actual temperature – set temperature (Delta T / Delta R)

Voltage range	-5 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	0.5 V/°C / -0.5 V/kΩ [1]

[1] Transducer/Thermistor

1.3.4 ITC110

Current control

Range of laser current I_{LD}	0 ... ± 1 A
Compliance voltage	> 4 V
Setting accuracy	± 2% fs typ.
Noise	< 6 µA
Drift (30 min. without changing the ambient temperature)	≤ 100 µA
Temperature coefficient	≤ 50 ppm/°C
Current limit	0 ... > 1 A
Setting accuracy of current limit	± 2% fs typ.

Power control

Photodiode current	5µA...2mA
Setting accuracy	± 2% fs typ.

Analog modulation input (LD MOD)

Voltage range	-5 ... +5 V
Input impedance	10 kΩ
Modulation coefficient (constant current)	200 mA/V
3 dB bandwidth (constant current)	DC...50 kHz
Modulation coefficient (constant power)	0.4 mA/V
TTL-modulation, rise-time (constant current)	yes, <50µs

Control outputs

Laser diode current (I_{LD}):

Voltage range	-5 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	5V/A± 2% fs typ.

Laser current limit ($I_{LD\ LIM}$):

Voltage range	0 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	5 V/A± 2% fs typ.

Photodiode current (I_{PD}):

Voltage range	0 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	2.5 V/mA± 2% fs typ.

Temperature control

TEC current I_{TEC}	0... ±2 A
TEC voltage U_{TEC}	>6 V
Max. output power P_{MAX}	16 W
Measurement accuracy	± 2% fs typ.
Noise and ripple	<1 mA
Current limit	0...>2 A
Resolution	10 mA with display
Accuracy	typ. ± 5% fs

Temperature sensor

Control range thermistor	0.1...80 kΩ
Resolution	100 Ω with display
Accuracy	± 2% typ.
Stability	2 Ω
Reproducibility	± 0.1 %

AD590/LM335

Control range	-20...+80 °C
Resolution	0.1 °C with display
Accuracy	±2 °C typ.
Stability	0.004 °C
Reproducibility	± 0.1 °C

Control input (T TUNE)

Voltage range	-5 ... +5 V
Input impedance	10 kΩ
Coefficient with thermistor	16 kΩ/V
Coefficient with AD590	20 °C/V

Temperature window	0.3°C ... ∞ / 0.3 kΩ ... ∞ [1)]

Control outputs

Set temperature (T_{SET} / R_{SET}), actual temperature (T_{ACT} / R_{ACT})

Voltage range	-1 ... +4V / +5mV ... +4V [1)]
Min. load resistance	500 kΩ
Output coefficient	50 mV/°C / 50 mV/kΩ ± 2% fs typ.[1)]

TEC current (I_{TEC})

Voltage range	-5V ... +5 V
Min. load resistance	500 kΩ
Output coefficient	2.5 V/A ± 2% fs typ.

TEC current limit ($I_{TEC\ LIM}$)

Voltage range	0 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	2.5 V/A ± 2% fs typ.

Difference actual temperature – set temperature (Delta T / Delta R)

Voltage range	-5 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	0.5 V/°C / -0.5 V/kΩ [1)]

[1] Transducer/Thermistor

1.3.5 ITC133

Current control	
Range of laser current I_{LD}	0 ... ± 3 A [1)]
Compliance voltage	> 4 V
Setting accuracy	± 2% fs typ.
Noise	< 25 µA
Drift (30 min. without changing the ambient temperature)	≤ 300 µA
Temperature coefficient	≤ 50 ppm/°C
Current limit	0 ... > 3 A
Setting accuracy of current limit	± 2% fs typ.
Power control	
Photodiode current	5µA...2mA
Setting accuracy	± 2% fs typ.
Analog modulation input (LD MOD)	
Voltage range	-5 ... +5 V
Input impedance	10 kΩ
Modulation coefficient (constant current)	600 mA/V
3 dB bandwidth (constant current)	DC...20 kHz
Modulation coefficient (constant power)	0.4 mA/V
TTL-modulation, risetime (constant current)	yes, < 100 µs
Control outputs	
Laser diode current (I_{LD}):	
Voltage range	-5 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	1.667 V/A ± 2% fs typ.

[1] The total combined current for the ITC133 is limited by the total thermal dissipation loss. When the standard heat sink is used, the total output current should be limited to 3A ($I_{LD} + I_{TEC} \leq 3A$). Optimized cooling by fan or bigger heat sink allows 3A LD and 3A TEC at the same time provided the power supply provides 6.1A

Laser current limit ($I_{LD\ LIM}$):

Voltage range	0 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	1.667 V/A ± 2% fs typ.

Photodiode current (I_{PD}):

Voltage range	0 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	2.5 V/mA ± 2% fs typ.

Temperature control

TEC current I_{TEC}	0... ±3 A [1)]
TEC voltage U_{TEC}	>6 V
Max. output power P_{MAX}	24 W
Measurement accuracy	typ. ± 2% fs
Noise and ripple	< 3 mA
Current limit	0...>3 A
Resolution	10 mA with display
Accuracy	± 5% fs typ.

Temperature sensor

Control range thermistor	0.1...80 kΩ
Resolution	100 Ω with display
Accuracy (f.s.)	± 2% typ.
Stability	2 Ω
Reproducibility	± 0.1 %

AD590/LM335

Control range	-20...+80 °C
Resolution	0.1 °C with display
Accuracy (f.s.)	typ. ±2 °C
Stability	0.004 °C
Reproducibility	± 0.1 °C

[1] The total combined current for the ITC133 is limited by the total thermal dissipation loss. When the standard heat sink is used, the total output current should be limited to 3A ($I_{LD} + I_{TEC} \leq$ 3A). Optimized cooling by fan or bigger heat sink allows 3A LD and 3A TEC at the same time provided the power supply provides 6.1A

Control input (T Tune)

Voltage range	-5 ... +5 V
Input impedance	10 kΩ
Coefficient with thermistor	16 kΩ/V
Coefficient with AD590	20 °C/V

Temperature window 0.3°C ... ∞ / 0.3 kΩ ... ∞ [1)]

Control outputs

Set temperature (T_{SET} / R_{SET}), actual temperature (T_{ACT} / R_{ACT})

Voltage range	-1 ... +4 V / +5 mV ... +4 V [1)]
Min. load resistance	500 kΩ
Output coefficient	50 mV/°C / 50 mV/kΩ ± 2% fs typ.[1)]

TEC current (I_{TEC})

Voltage range	-5V ... +5 V
Min. load resistance	500 kΩ
Output coefficient	1.667 V/A ± 2% fs typ.

TEC current limit ($I_{TEC\ LIM}$)

Voltage range	0 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	1.667 V/A ± 2% fs typ.

Difference actual temperature – set temperature (Delta T / Delta R)

Voltage range	-5 ... +5 V
Min. load resistance	500 kΩ
Output coefficient	0.5 V/°C / -0.5 V/kΩ [1)]

[1] Transducer/Thermistor

1.3.6 Digital control signals

INPUTS:

LD ON IN	High => Laser ON
TEC ON IN	High => TEC ON
min. high level input voltage	2.0 V
max. low level input voltage	1.1 V
max. input voltage	25 V

TTL MOD	High => Laser ON (int. pull up to +5 V)
min. high level input voltage	1.8 V
max. low level input voltage	1.2 V
max. input voltage	25V

OUTPUTS (Open collector, no internal pull up's):

LD ON OUT	Low = Laser ON
LIMIT LD	Low = Laser limit reached
TEC ON OUT	Low = TEC on
TEMP ERR	Low = TEC window exceeded
OTP	Low = Heat sink over temperature
max. low level output voltage:	
(sink current = 350 mA)	1.6 V
max. sink current	500 mA
max. external pull up voltage	50 V

INTERLOCK:

Please refer to 2.5.6.

1.4 Dimensions of ITC100

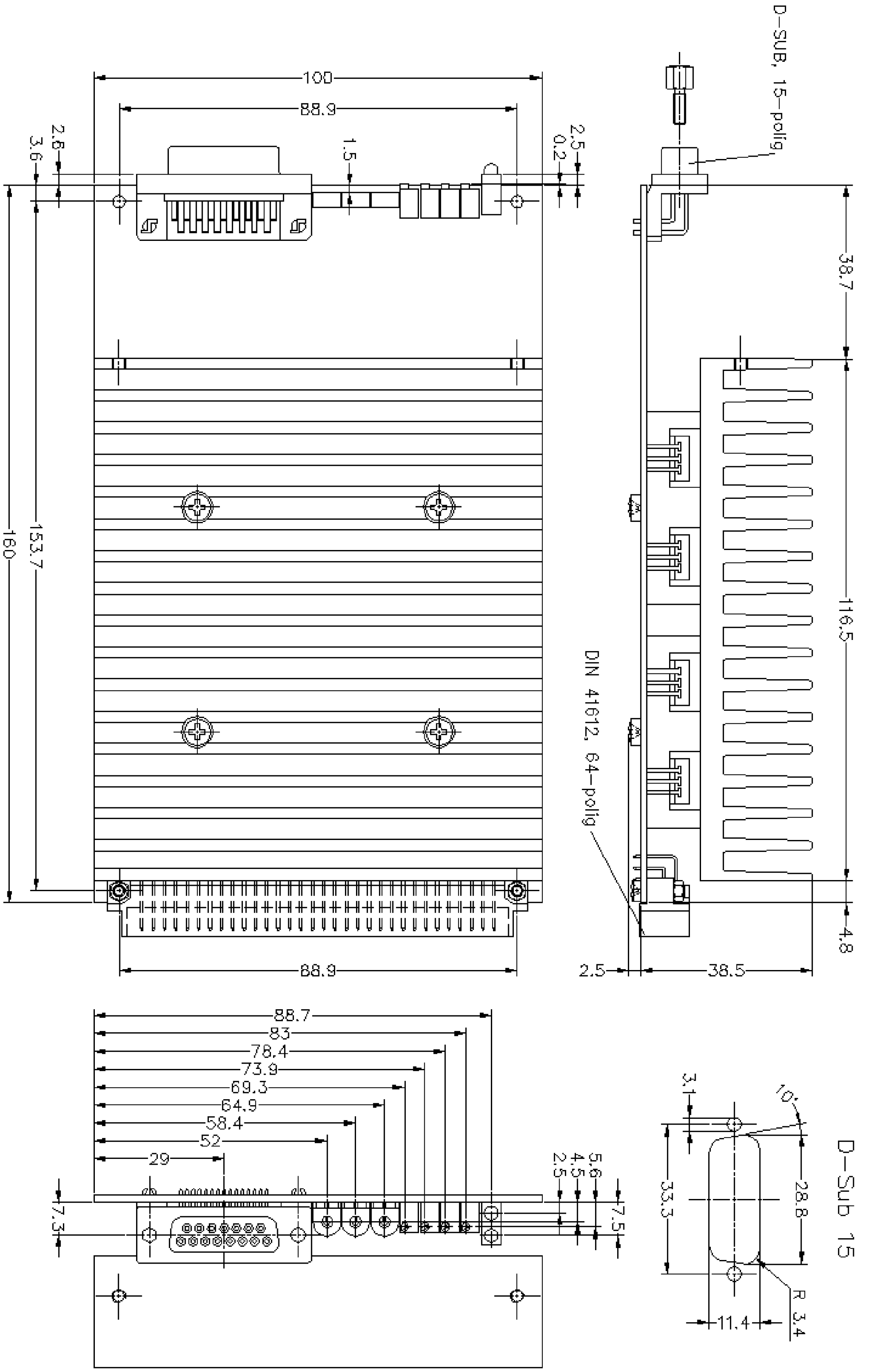


Figure 1 ITC100 dimensions (mm)

2 Operating the ITC1xx

2.1 Operating elements

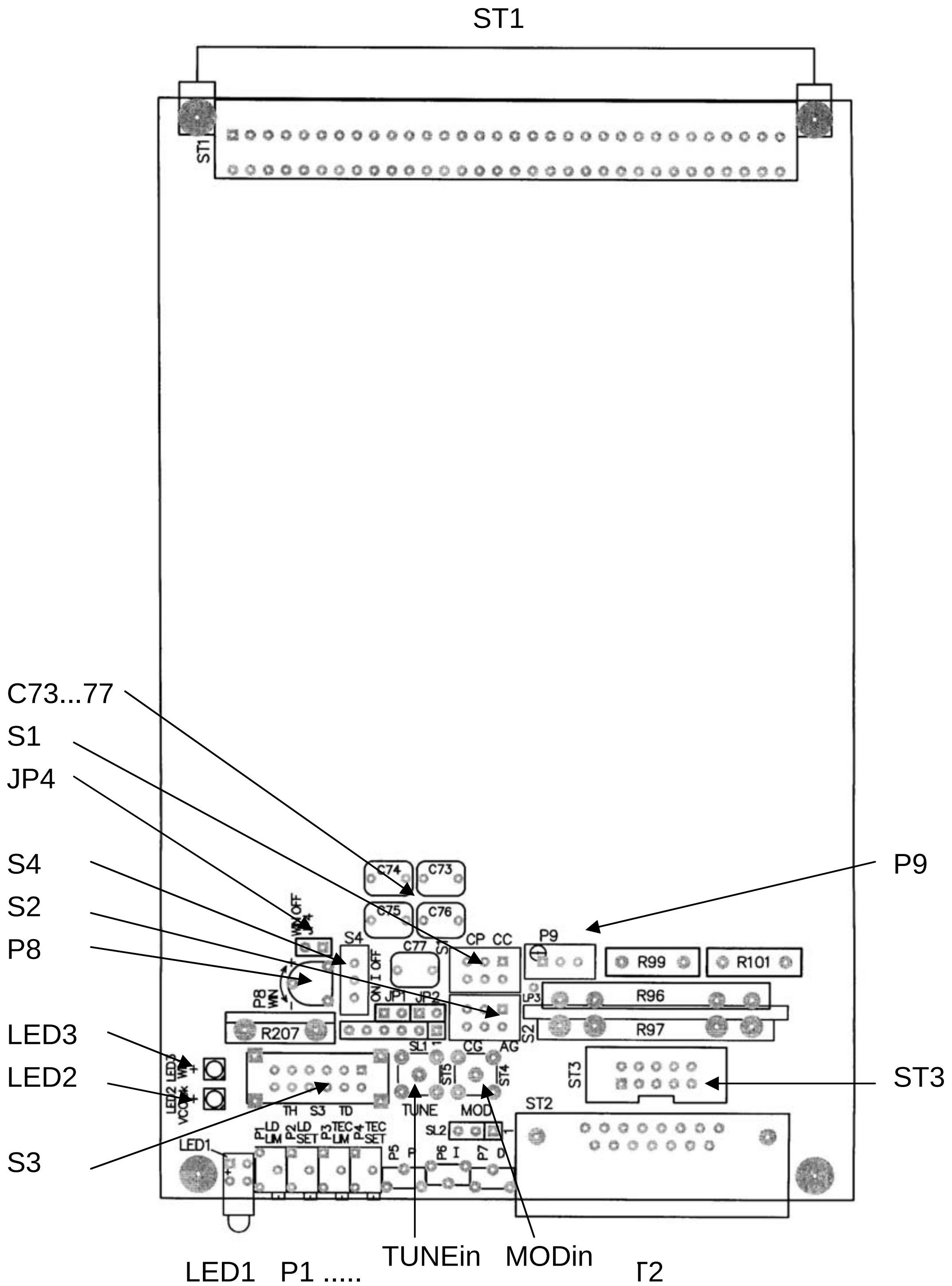


Figure 2 ITC100 operating elements

2.1.1 Potentiometer

P1 Sets the laser diode limit current

P2 Adjusts the laser set current or power (depending on mode of operation, CC or CP)

P3 Sets the TEC current limit

P4 To adjust the TEC set temperature or resistance (depending on the sensor chosen, transducer or thermistor)

P5 TEC P share

P6 TEC I share

P7 TEC D share

P8 Defines the TEC temperature window

P9 For CMR adjustment. Should not be changed by the user.

2.1.2 Switches

S1 LDC mode
Switch to the left in Figure 2 defines constant power mode (CP)
Switch to the right defines constant current mode (CC)

S2 LDC polarity
Switch to the left in Figure 2 defines cathode grounded(CG)
Switch to the right defines anode grounded (AG)

S3 TEC sensor transducer / thermistor
Switch to the left in Figure 2 defines thermistor
Switch to the right defines transducer (AD590 etc.)

S4 TEC I-share ON/OFF
Switch in direction ST2 in Figure 2 turns TEC I-share ON
Switch in direction ST1 turns TEC I-share OFF.

2.1.3 Jumper

JP1 Bias +

Jumper closed: bias+ connected to ST2 Pin 12
Jumper open : bias+ disconnected from ST2 Pin 12[1)]

JP2 Bias -

Jumper closed: bias- connected to ST2 Pin 9
Jumper open : bias- disconnected from ST2 Pin 9[1)]

JP4 TEC window

Jumper closed: TEC window OFF
Jumper open: TEC window ON

2.1.4 LED's

LED1a	Laser ON (upper LED)
LED1b	TEC ON (lower LED, nearest to pcb)
LED2	Power supply o.k.
LED3	TEC temperature out of window

[1] Compatibility to *Thorlabs* LDH series with connection cable CAB 430

2.2 Connecting components

2.2.1 I/O-Jack 64pin ST1.

Power supply

A30,C30	Supply voltage +	+11.4..+15.8V / 2.4A/3.2A/3.2A [1) 2)]
A31,C31	Supply voltage ground	
A32,C32	Supply voltage -	-11.4..-15.8V / 2.4A/3.2A/3.2A [1)]

Analog signals

A8,C8,A14,A16, A18,A21,C21	Measurement ground

PIN	Function	Input/Output	Range / Coefficient	
TEC				
A4,C4	TEC - (ground)	O		
A5,C5	TEC +	O	±2A/2A/3A / ±6V [1)]	
C6	AD590 +	I	-20..+80°C	
A6	AD590 -	I	253.2..353.2µA	1µA/°C

[1] ITC102/110/133

[2] Without display

PIN	Function	Input/Output	Range / Coefficient	
A7	Thermistor ground	I		
C7	Thermistor	I	100Ω..80kΩ	
C9	ITEC	O	-5..+5V	2.5/2.5/1.667 V/A [1)]
A9	ITEC LIM	O	0..+5V	2.5/2.5/1.667 V/A [1)]
A10	Delta T / Delta R	O	-5..+5V	0.5V/°C / -0.5V/Ω [2)]
C10	TACT / RACT [3)]	O	-1..+4V / +5mV..+4V[2)] 50mV/°C / 50mV/kΩ [2)]	
C11	TSET / RSET	O	-1..+4V / +5mV..+4V [2)] 50mV/°C / 50mV/kΩ [2)]	
A11	T TUNE	I	-5..+5V	20°C/V / 16kΩ/V [2)]

LDC

A15	LD MOD	I	-5..+5 V	40/200/600 mA/V [1)]
A19	IPD [3)]	O	0..+5V	2.5V/mA
A20	ILD [3)]	O	0..+5V(CG)/ 0..-5V(AG) 25 / 5 / 1.667V/A [1)]	
C20	ILDLIM	O	0..+5V	25 / 5 / 1.667 V/A [1)]
A22	Bias -	O	-5V const.	
C22	Bias +	O	+5V const.	
A23	Monitor diode cathode	I		
C23	Monitor diode anode	I	0..2mA (floating diff. input)	
A24,C24	Laser diode anode (polarity CG)	O	+0.2A/1A/3A / 4V[1)]	
A25,C25	Laser diode ground	O		
A26,C26	Laser diode cathode (polarity AG)	O	-0.2A/1A/3A / 4V [1)]	

[1] ITC102/110/133

[2] Transducer/Thermistor

[3] If a long connection cable is connected to this output, a 1 kΩ series resistor should be inserted as close as possible to the output pin.

PIN	Function	Input/Output	Range / Coefficient
Digital signals			
TEC			
A13	TEC ON IN	I	Logical level High => TEC on
A12	TEC ON OUT	O	Low = TEC on (open collector)
C12	TEMP ERR	O	Low = TEC window exceeded (open collector, OC)
C13	OTP	O	Low = heat sink over-temperature (Open Coll.)
C14	Digital ground		
LDC			
C15	LD ON IN	I	High => laser on
A17	TTL MOD	I	High => laser on
C16	LD ON OUT	O	Low = laser on (open collector)
C18	LIMIT LD	O	Low = laser limit reached (open collector)
C17	Interlock	I/O	Closed to ground (R < 430 Ω)

	C1	A1	
	C2	A2	
	C3	A3	
TEC - (ground)	C4	A4	TEC - (ground)
TEC +	C5	A5	TEC +
AD 590+	C6	A6	AD 590-
Thermistor	C7	A7	Thermistor ground
GND	C8	A8	GND
ITEC	C9	A9	ITEC LIM
Tact/Ract	C10	A10	Delta T/R
Tset/Rset	C11	A11	T-Tune
TEMP ERR	C12	A12	TEC ON out
OTP	C13	A13	TEC ON in
Digital ground	C14	A14	GND
LD ON in	C15	A15	LD MOD
LD ON out	C16	A16	GND
INTERLOCK	C17	A17	TTL MOD
LIMIT LD	C18	A18	GND
	C19	A19	IPD
ILD LIM	C20	A20	ILD
GND	C21	A21	GND
Bias +	C22	A22	Bias -
Mon. Diode Anode	C23	A23	Mon. Diode Cathode
LD Anode	C24	A24	LD Anode
LD ground	C25	A25	LD ground
LD Cathode	C26	A26	LD Cathode
	C27	A27	
	C28	A28	
	C29	A29	
Supply +	C30	A30	Supply +
Supply Ground	C31	A31	Supply Ground
Supply -	C32	A32	Supply -

Figure 3 ST1 64pin I/O-jack

2.2.2 15-pin D-SUB I/O-jack ST2

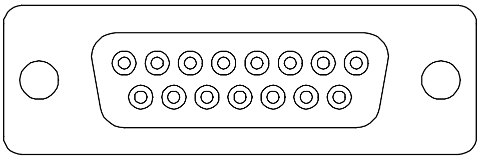


Figure 4 The 15 pin D-SUB I/O jack (f)

PIN	Function	Input/Output	Range
8	TEC - (ground)	O	
7	TEC +	O	±2A/2A/3A / ±6V [1)]
6	AD590 +	I	
13	AD590 -	I	253.2..353.2µA
14	Thermistor ground	I	
15	Thermistor	I	100Ω..80kΩ
11	Laser diode anode (polarity CG)	O	+0.2A/1A/3A 4V [1)]
3	Laser diode ground		
10	Laser diode cathode (polarity AG)	O	-0.2A/1A/3A 4V [1)]
2	Monitor diode cathode	I	
4	Monitor diode anode	I	0..2mA (floating diff.input)
9	Bias -	O	-5V const.[2)]
12	Bias +	O	+5V const.[3)]
1	Interlock	I/O	Closed to ground (R < 430 Ω)
5	Interlock ground		

[1] ITC102/110/133

[2] With JP2 set

[3] With JP1 set

2.2.3 ST3 Display jack

PIN	Function	Input / Output
1	-9V (not used)	
2	GND	
3	+5V	
4	IPD_Disp	O
5	ILD_Disp	O
6	ILDLim_disp	O
7	TSET_Disp	O
8	TACT_Disp	O
9	ITECLIM_Disp	O
10	Measure ground	

2.2.4 SMB coaxial inputs

ST4	Laser diode modulation input LD MOD		
		-5..+5V	40/200/600mA/V [1)]
ST5	Temperature tune input T TUNE		
		-5..+5V	20°C/V / 16kΩ/V [2)]

[1] ITC102/110/133

[2] Transducer/Thermistor

2.3 Connecting the supply

The OEM board ITC100 requires a supply voltage of ±12 ... 15 V for internal operation and to operate the laser diode and the TEC element.

The ±12 ... 15 V supply must be regulated and free of ripple. Definitive limit values for the voltages are ±11.4 V resp. ±15.8 V. Voltages below this window will cause the unit to operate improperly, voltages above may cause damage to the ITC100.

The necessary currents the power supply must be able to deliver are:

ITC102 :2.4 A [1]; ITC110 :3.2 A [1]; ITC133 :3.2 A [1][2]

With ±15 V supply and high output currents at low output voltages the internal power dissipation of the unit increases significantly. This could cause a degradation of the technical specifications. In these cases the use of a ±12 V supply is advised.

The increase of the heat sink temperature for a vertically installed OEM board without forced air cooling can be calculated as follows:

$$\Delta T = [(Us - U_{LDCOUT}) \cdot I_{LDCOUT} + (Us - U_{TECOUT}) \cdot I_{TECOUT} + 2.5 Watt] \cdot 1.6°C / Watt$$

(U_S = Supply voltage)

<u>Example:</u>
I_{TECOUT} =2A; U_{TECOUT} = 2.5V; I_{LDCOUT} = 0.2 A; U_{LDCOUT} = 2V
US = ±12V:-> ΔT = 37.6 K : ->$T_{HEATSINK}$ = 62.6 °C at 25°C ambient temperature.

NOTE

Using the ITC1xx with the Display ITC100D additionally increases the heat sink temperature by about 3°C.
Also horizontally mounting of the unit increases the temperature! For optimum specs forced air cooling may be required.

---

[1] Without display ITC100D

[2] The total combined output current for the ITC133 is limited by the total thermal dissipation loss. When the standard heat sink is used, the total output current should be limited to 3A ($I_{LD} + I_{TEC} \leq 3A$). optimized cooling by fan or bigger heat sink allows 3A LD and 3A TEC at the same time provided the power supply provides 6.1A

The maximum allowed heat sink temperature is +85°C. Above the over temperature protection gets active and switches off the TEC and LDC outputs until the temperature has dropped by about 10°C.

2.4 Connecting the laser diode and photo diode

The laser diode controller ITC102 / ITC110 / ITC133 by *Thorlabs* are designed to drive laser diodes up to a maximum current range of 0,2 / 1 / 3[1)] A either with anode or cathode grounded.
The photodiode can be used either floating, or with anode or cathode grounded and with or without bias voltage.

Connect the laser diode and, if provided, the photodiode with shielded cables to the output connector ST2 or ST1 according to the configurations shown in the following part.

NOTE:

Disconnecting the laser diode during operation may lead to destruction of the laser diode!

[1] See Footnote 2 on previous page

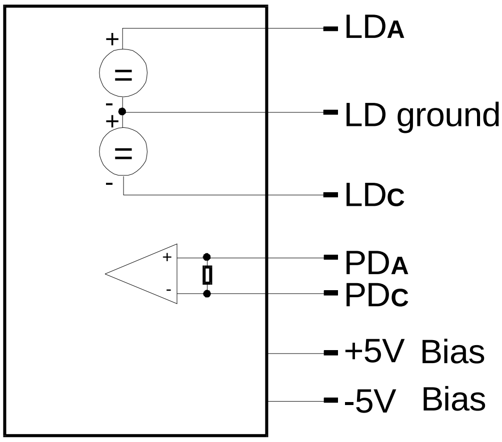


Figure 5 Principal circuit of the ITC1xx

The laser diode is always sourced with respect to ground. Compared to a floating driver stage, this operation mode has the advantages of higher security for the laser diode and better stability of the laser current.

Connect the laser diodes and the photodiodes with shielded, twisted pair cables. The anode and cathode connection of each device should be twisted.

The connections for the different possible combinations are shown in the following figures.

2.4.1 Laser AG / photo diode CG, no bias

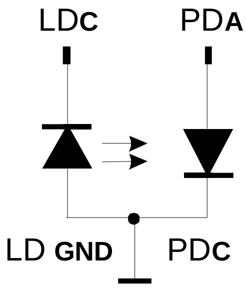


Figure 6 Laser diode AG, photo diode CG, no bias

2.4.2 Laser AG / photo diode AG, no bias

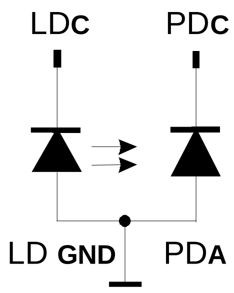
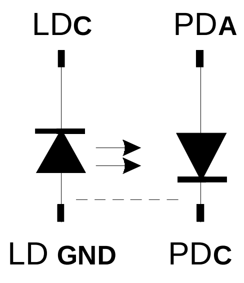


Figure 7 Laser diode AG, photo diode AG, no bias

2.4.3 Laser AG / photo diode floating, no bias



a connection (dashed line) may be done either at the laser or at the connector

Figure 8 Laser diode AG, photo diode floating, no bias

2.4.4 Laser AG / photo diode CG, 5 V bias

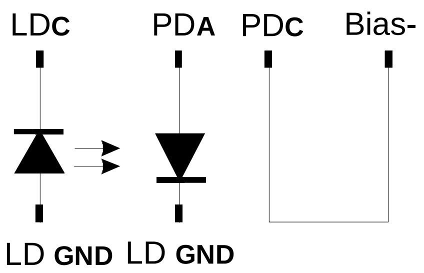


Figure 9 Laser diode AG, photo diode CG, 5V bias

2.4.5 Laser AG / photo diode AG, 5 V bias

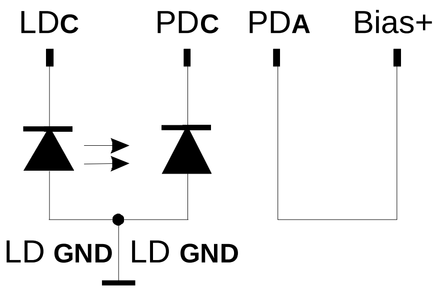


Figure 10 Laser diode AG, photo diode AG, 5V bias

☝ **Attention** ☝

Reverse connection of the photo diode can cause permanent damage to the device when using a bias voltage. Check control voltage output I_{PD} (A19) prior to setting the bias voltage. The output must be positive!

Laser CG / photo diode CG

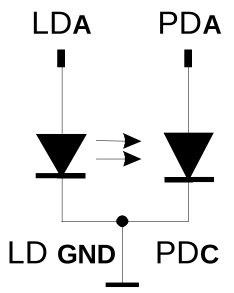


Figure 11 Laser diode CG / photo diode CG, no bias

2.4.6 Laser CG / photo diode AG

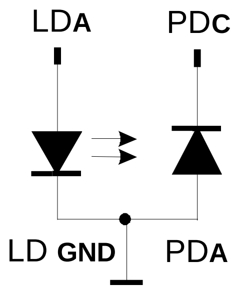


Figure 12 Laser diode CG / photo diode AG, no bias

2.4.7 Laser CG / photo diode floating, no bias

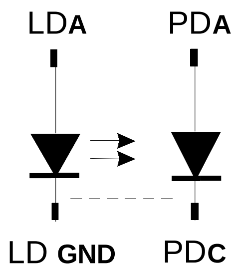


Figure 13 Laser diode CG / photo diode floating, no bias

a connection (dashed line) may be done either at the laser or at the connector

2.4.8 Laser CG / photo diode CG, 5V bias

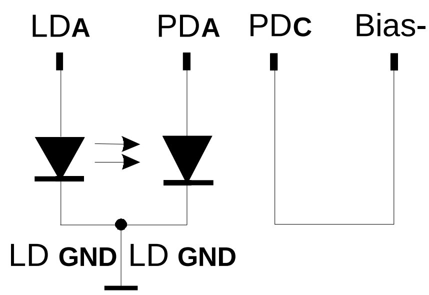


Figure 14 Laser diode CG / photo diode CG, with 5V bias

2.4.9 Laser CG / photo diode AG, 5V bias

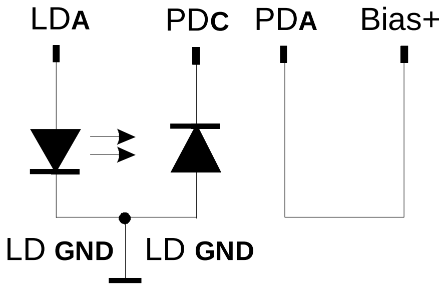


Figure 15 Laser diode CG / photo diode AG, 5V bias

☝ Attention ☝

Reverse connection of the photo diode can cause permanent damage to the device when using a bias voltage. Check control voltage output I_{PD} (A19) prior to setting the bias voltage. The output must be positive!

2.5 Connecting temperature sensor and interlock

2.5.1 Connecting a thermistor

The thermistor is connected between pin 14 and pin 15.
(Values in parenthesis correspond to the 64-pole jack ST1)

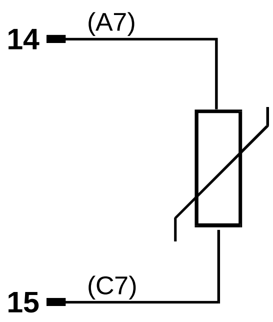


Figure 16 Connecting a thermistor

2.5.2 Connecting an AD590

The IC-temperature sensor AD590 is connected between pin 13 (-) and pin 6 (+).
(Values in parenthesis correspond to the 64-pole jack ST1)

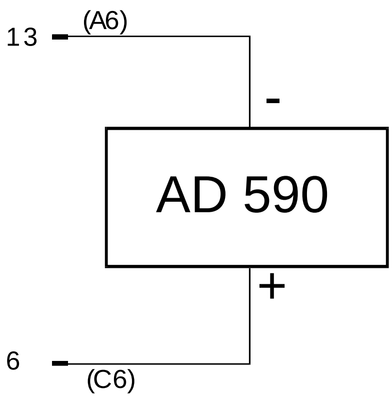


Figure 17 Connecting an AD590

2.5.3 Connecting an LM335

The IC-temperature sensor LM335 is connected between pin 6 (+), pin 13 (via 10 kΩ resistor) and pin 14 (-).
(Values in parenthesis correspond to the 64-pole jack ST1)

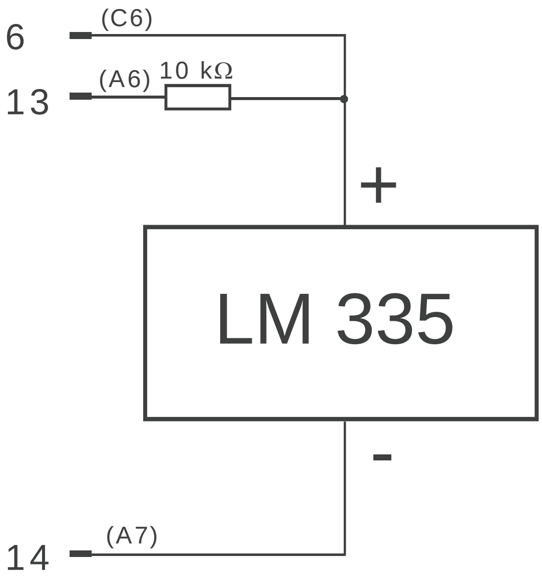


Figure 18 Connecting a LM335

2.5.4 Connecting the TEC element

Connect the TEC element to pin 7 (**+**) and pin 8 (**-**).
(Values in parenthesis correspond to the 64-pole jack ST1)

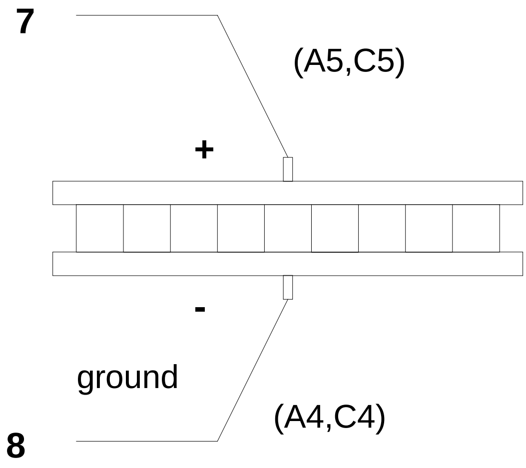


Figure 19 Connecting a TEC element

☝ Attention ☝

A reverse poled TEC element may lead to thermal runaway and destruction of the connected components.

2.5.5 Polarity check of the TEC element

Presettings

- Connect TEC element and temperature sensor. The sensor must have good thermal contact to the active surface of the TEC element.
- Switch on the laser diode control system ITC1xx.
- Select the correct type of sensor (S3).
- Set the appropriate value for I_{MAX}[1)].

Polarity check of the TEC element

- Observe T_{ACT} (or R_{ACT}) and switch on the module.

➔ If T_{ACT} (or R_{ACT}) runs away from T_{SET} (or R_{SET}), the TEC element is reverse poled. Change polarity and repeat the procedure.

➔ If T_{ACT} (or R_{ACT}) is oscillating around the value T_{SET} (or R_{SET}) the TEC element is connected correctly, but the P-, I- and D-share values of the control loop are still incorrect.

➔ If T_{ACT} (or R_{ACT}) is settling properly to the value T_{SET} (or R_{SET}) the TEC element has been connected correctly, the values for the P-, I- and D-share of the control loop might still be improved.

➔ (Refer to chapter 2.7, "PID adjustment" starting on page 42)

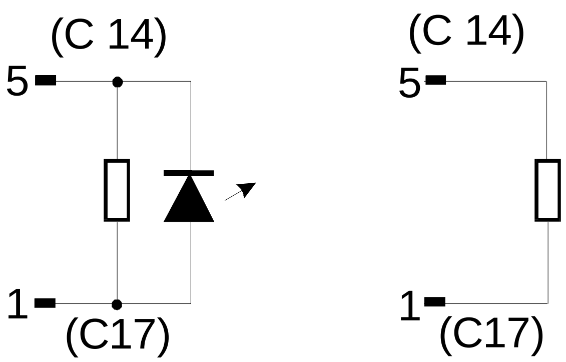
[1] The total combined current for the ITC133 is limited by the total thermal dissipation loss. When the standard heat sink is used, the total output current should be limited to 3A ($I_{LD} + I_{TEC} \leq 3A$). Optimized cooling by fan or bigger heat sink allows 3A LD and 3A TEC at the same time provided the power supply provides 6.1A

2.5.6 Interlock and control LED for LASER ON

Pin 1 of the output connector (ST2) is a test contact to determine whether a laser diode is connected or not or if the connection to the laser diode has been interrupted during operation.

Connect Pin 1 externally to Pin 5. This bridge disconnected, the ITC1xx is switched into LASER OFF mode automatically.

An external LED with a 1 kΩ resistor in parallel may be connected between pin 1 (anode) and pin 5 (cathode) of the output connector to indicate the LD ON status.
The LED current is about 3.5 mA.



1 kΩ 0....430 Ω

(Values in parenthesis correspond to the 64-pole jack ST1)

Figure 20 Interlock connection of ITC1xx

2.6 Some practical connection schemes

Here are some examples how to do first experiments with the ITC100

2.6.1 Operation as laser current controller

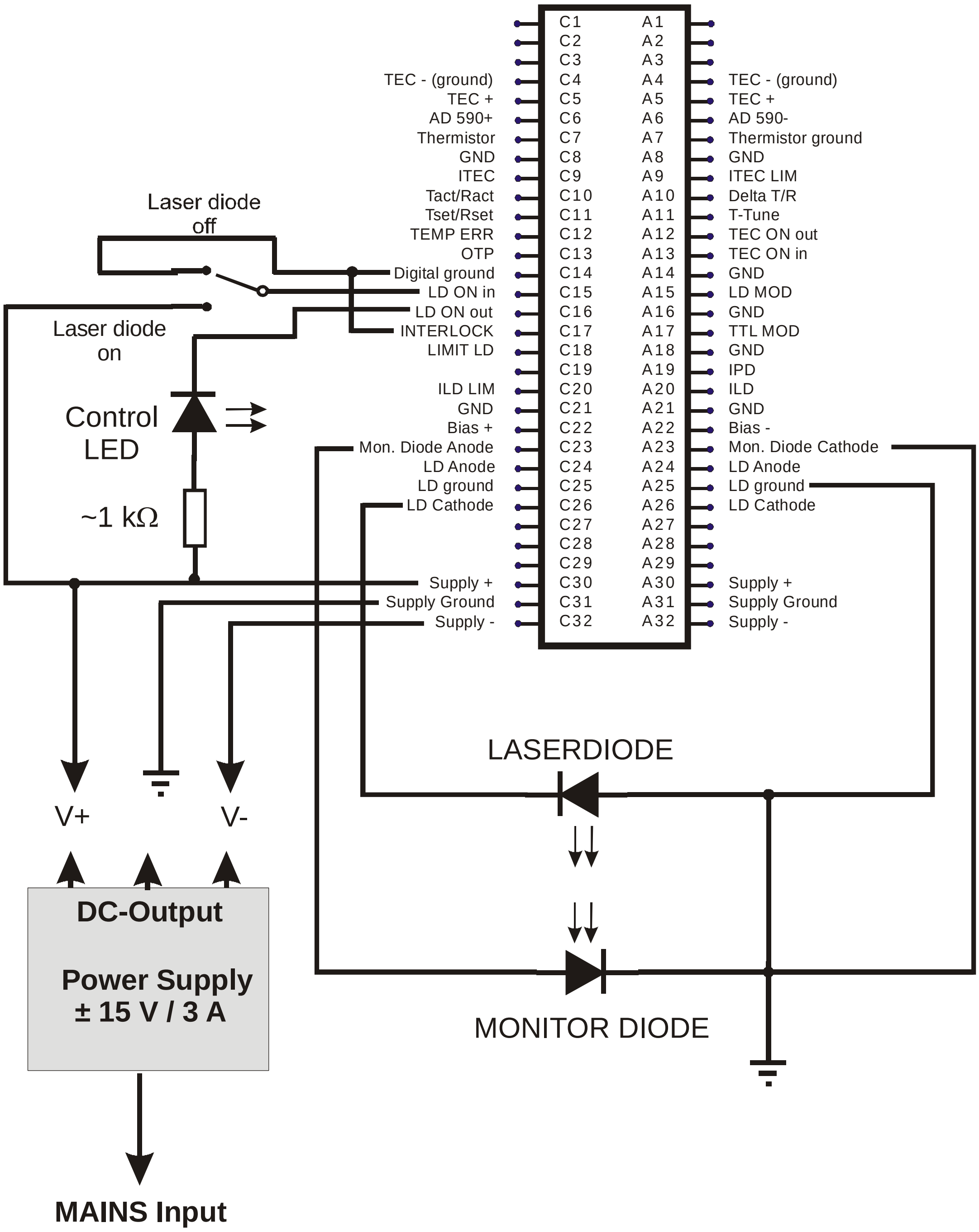


Figure 21 Laser current controller, version a

Here a laser diode with polarity AG (anode grounded) and a photo diode with polarity CG (cathode grounded) with no bias voltage are connected to the 64-pin DIN jack.

The same configuration is possible using the 64-pin jack as well as the 15-pin D-SUB connector at the front panel:

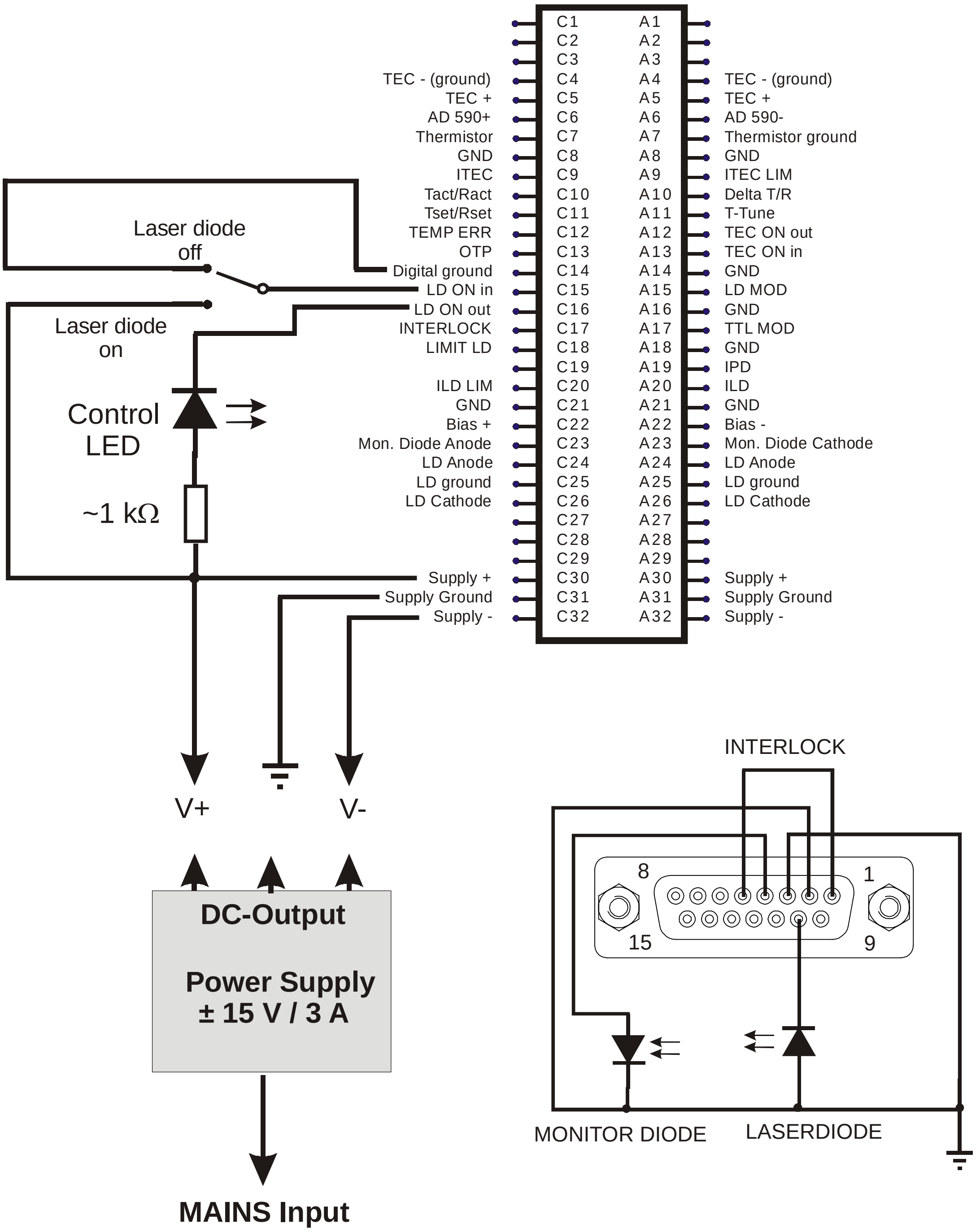


Figure 22 Laser current controller, version b

2.6.2 Operation as temperature controller

Using only the 64-pin jack:

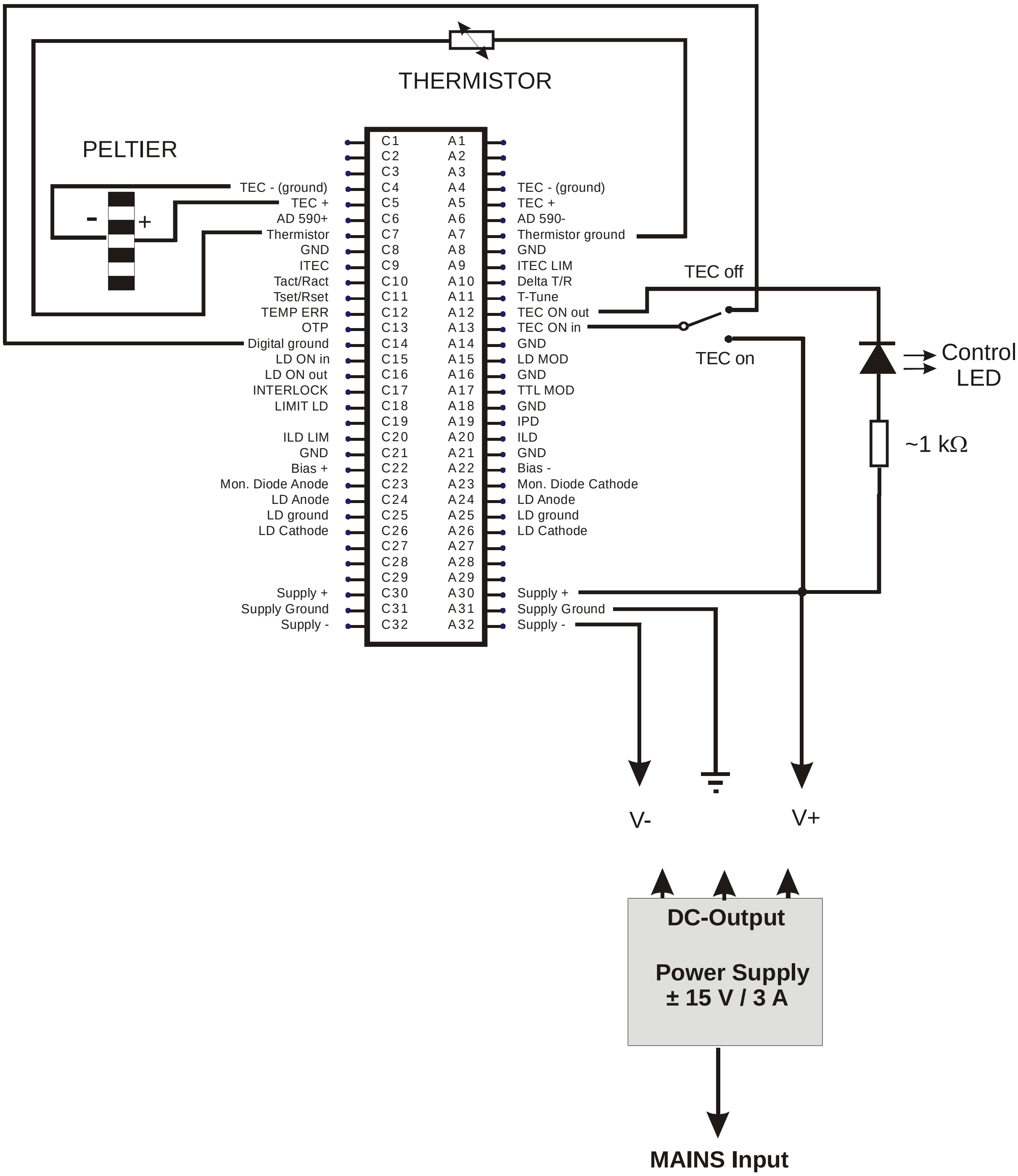


Figure 23 Temperature Controller, version a

Using both connectors

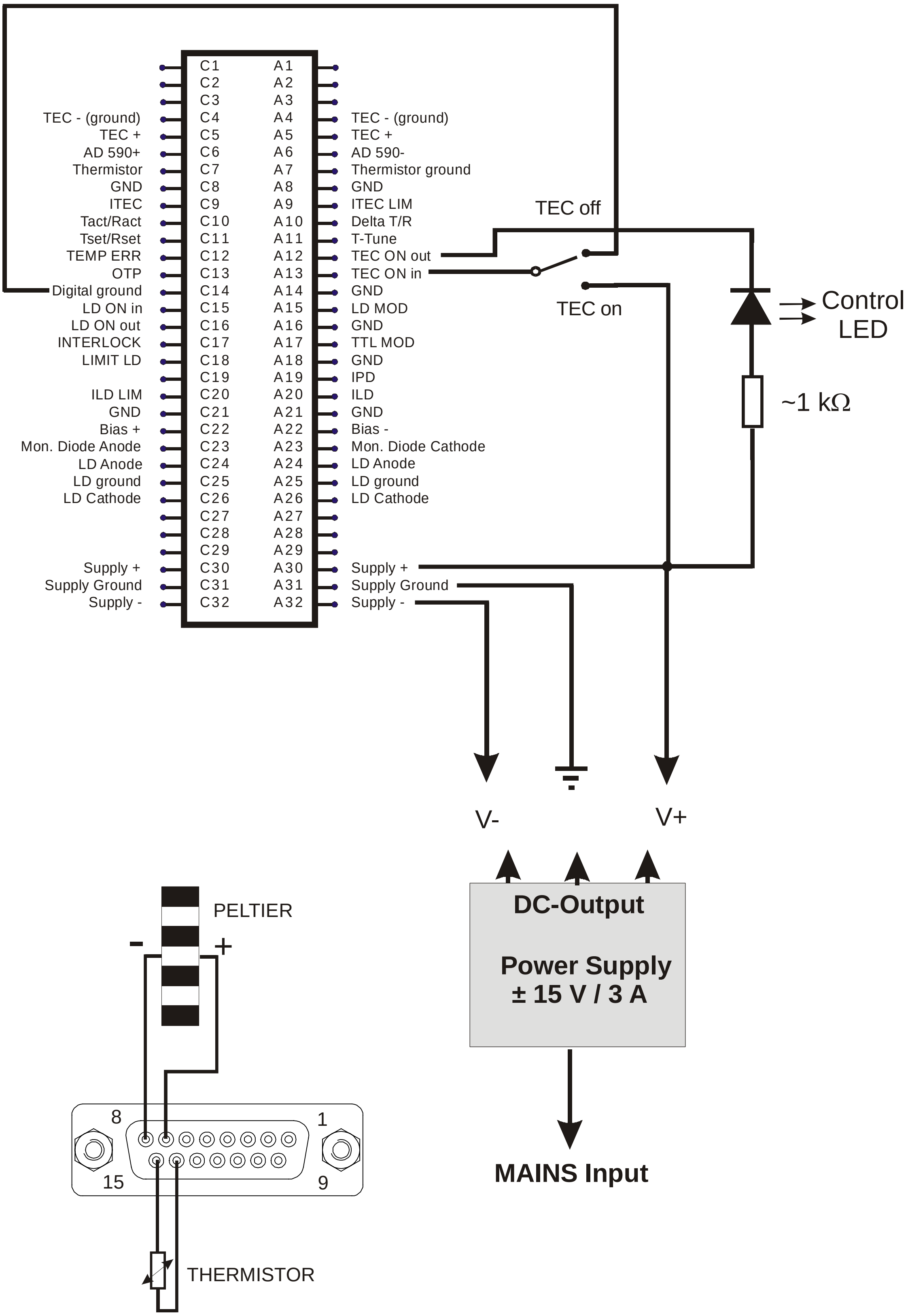


Figure 24 Temperature Controller, version b

2.7 PID adjustment

Temperature control loops are comparatively slow with control oscillations in the Hertz range.

The PID adjustment will optimize the dynamic behavior. With the ITC1xx the three parameters P, I and D can be set independently from 5% to 100%.

Example of a PID adjustment

(Pre-conditions: All limit values have been set correctly, all polarities are correct, all set and relevant calibration values are entered, ambient temperature is about 20°C)

- Switch off the I-share (switch S4 to OFF).
- Set the P-, I- and D-share to minimum (turn potis counter clockwise).
- Switch on the output and observe the temperature.

P-share

- Change repeatedly between set temperatures of about 18 °C and 22 °C while observing the settling behavior of the actual temperature.
  Increase the P-share gradually. Higher values will increase the settling speed, too high values make the system oscillate.
  The P-share has been set correctly when the actual temperature remains stable near the set temperature after only 2-3 overshoots.

D-share

- Change repeatedly between set temperatures of 18 °C and 22 °C while observing again the settling behavior of the actual temperature.
  Increase the D-share gradually. Higher values will decrease the amplitude of the overshoots.
  The D-share is set correctly when the actual temperature remains stable near the set temperature after a minimum of overshoots.

I-share

- Turn on the I-share again (switch S4 to ON).

- Again change repeatedly between set temperatures of 18 °C and 22 °C.
  Increase the I-share gradually. Higher values will accelerate the settling to the set temperature.
  The I-share is set correctly when the actual temperature reaches the set temperature in shortest time without overshoots.

NOTE

If the adjustment ranges of I- and D-share are insufficient you can use additional foil capacitors on place C73 for the D-share and on places C75,C76 and C77 for the I-share, typically 0.47 µF ... 3.3 µF (see Figure 2).

2.8 Setting the temperature window.

Keep your temperature sensor on a constant temperature (with the TEC switched off). Adjust the set temperature in such a way that the difference between actual and set temperature corresponds to the desired temperature window.

Now remove jumper 4 and set potentiometer P8 fully clockwise (window = ∞).

Rotate P8 slowly counter clockwise until LED3 lights up.

2.9 Switching the module on and off

The laser current and the temperature controller are switched on by logic signals.
The signals are applied to I/O-jack ST1:

➔ Figure 3)

pin C15: Laser current on/off
pin A13: Temperature controller on/off.

The minimum high level to switch on is +2 V, the maximum input level +25 V. Thus either TTL or CMOS signals can be applied, or for constant operation these inputs can be connected to the positive supply voltage.
The maximum voltage level to switch the units off, must not exceed +1.1 V!
Input resistance is about. 10 kΩ.

Please remember that the interlock-line must be closed to switch on the laser current.

2.10 The display module ITC100D

P1 ....P6

Figure 25 The ITC100D display module

The display is a 3 ½ digit LED-display with user selectable decimal points.

The module ITC100D allows to display digitally the switch selectable values:
(from counter-clockwise to clockwise)

- Photo diode current I_{PD}
- Laser diode current I_{LD}
- Laser diode limit current I_{LIM}
- Set temperature[1] (or resistance[2]) value T_{SET}
- Actual temperature[1] (or resistance[2]) value T_{ACT}
- TEC limit current I_{TLIM}

[1] with transducer

[2] with thermistor

2.10.1 Connecting the ITC100D

The ITC100D can either be mounted directly to the ITC1xx board or separately e.g. to a front panel.

To connect the display to the ITC1xx board use the two screws and distance holders delivered with the display module.
The display is mounted to the ITC heat sink in an 90 ° angle.
The flat band connection cable jack is inserted into ST3 on the ITC board.
No further adjustment is necessary.

2.10.2 Jumper setting

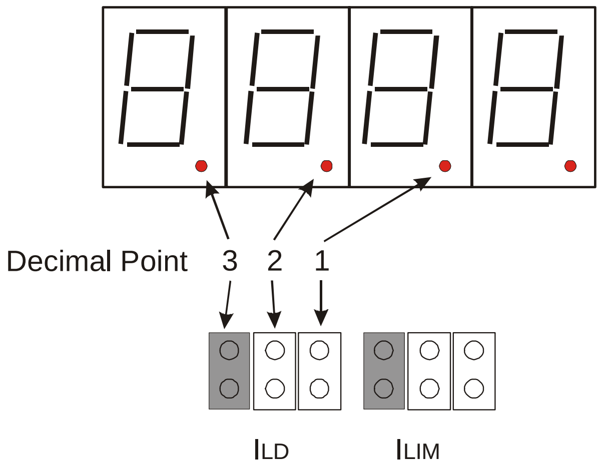


Figure 26 ITC100D Jumper settings

Two jumper banks allow the setting of decimal points corresponding to the two measurement values I_{LD} and I_{LIM}.

Type	I_{PD} Unit	I_{LD} pos.	I_{LD} Unit	I_{LIM} pos.	I_{LIM} Unit	T_{SET} Unit	T_{ACT} Unit	I_{TELIM} Unit
ITC102	mA	1	mA	1	mA	°C/kΩ[1)]	°C/kΩ[1)]	A
ITC110	mA	3	A	3	A	°C/kΩ[1)]	°C/kΩ[1)]	A
ITC133	mA	2	A	2	A	°C/kΩ[1)]	°C/kΩ[1)]	A

[1] Transducer / Thermistor

2.10.3 Front panel mounting scheme

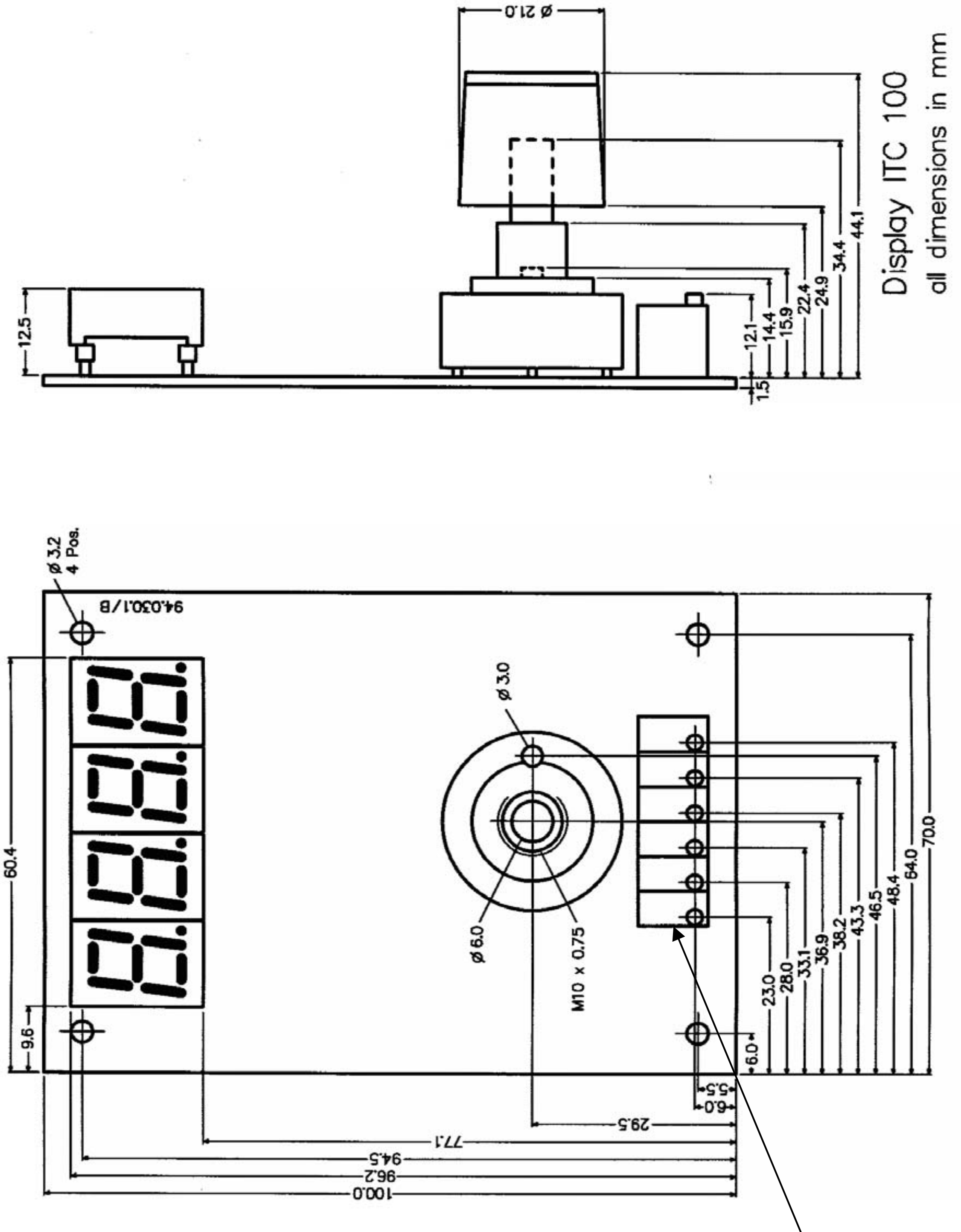


Figure 27 ITC100D mounting scheme

Potentiometers for calibration

NOTE

Not made to scale!!!

2.10.4 Front panel ITC100F for ITC100 with ITC100D

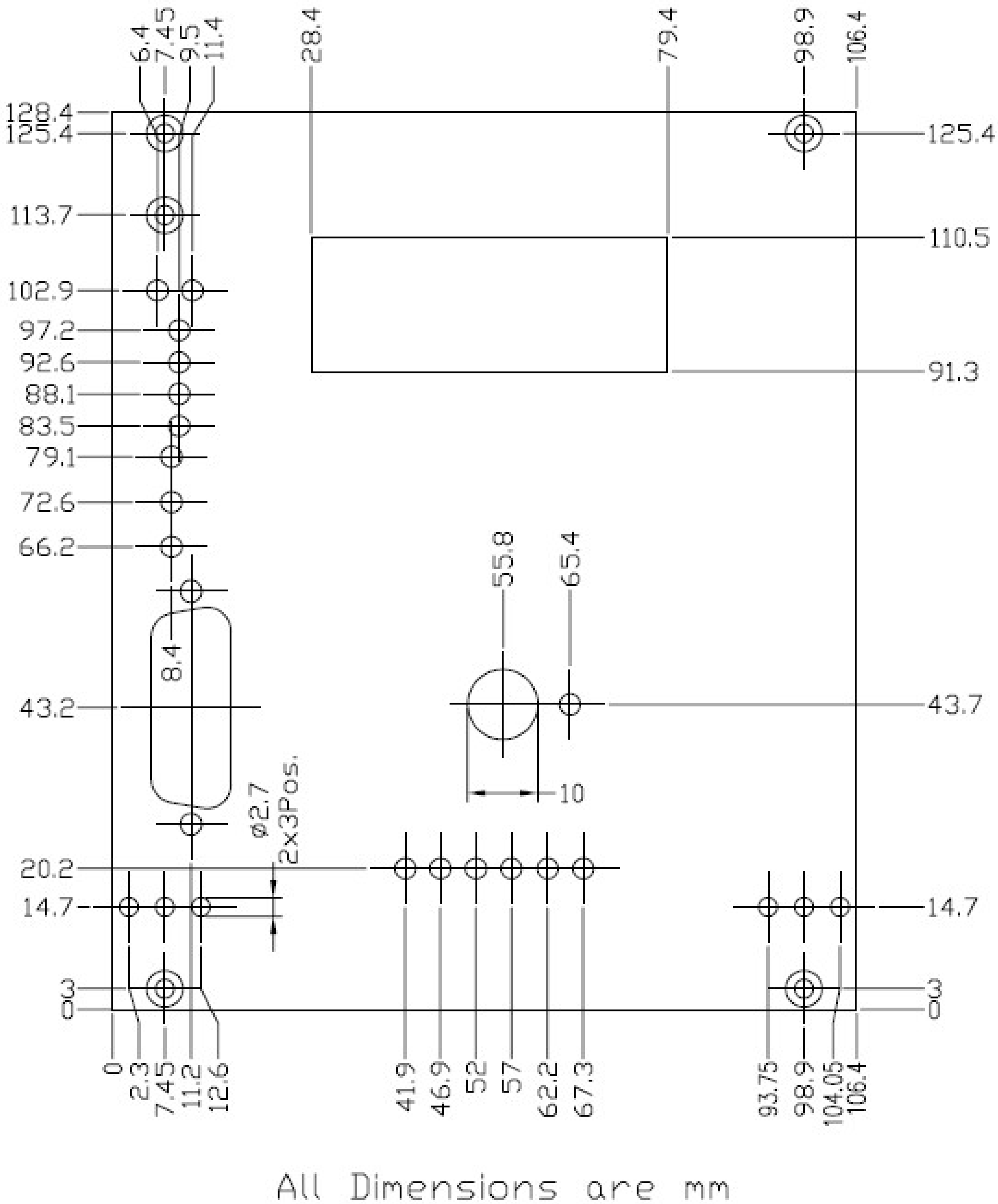


Figure 28 Front panel ITC100F dimensions (mm)

NOTE

Not made to scale!!!

2.10.5 Proposal for a custom front panel for ITC100 with ITC100D

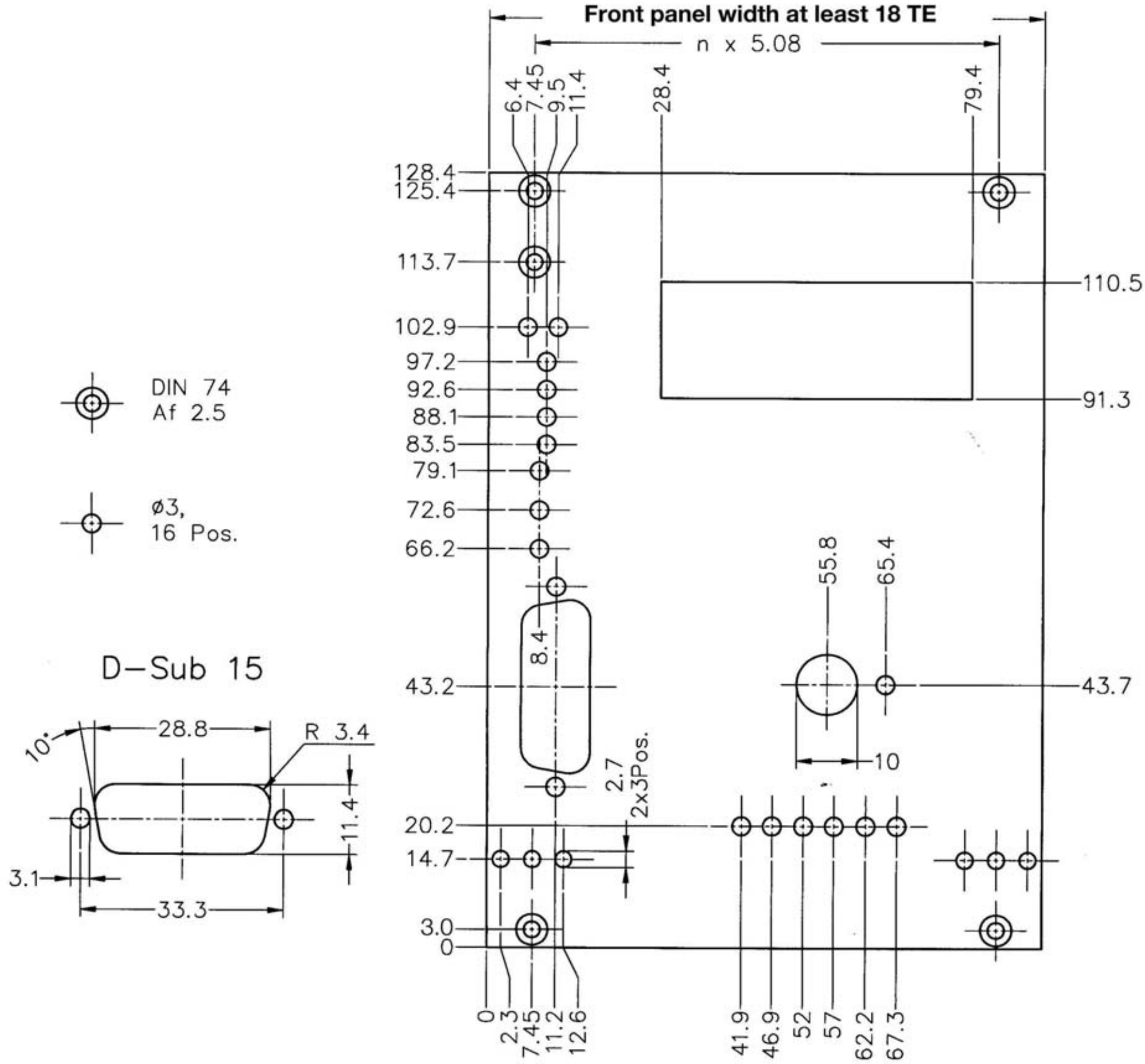


Figure 29 Custom front panel dimensions (mm)

NOTE

This is a proposal for a custom front panel. This is not delivered by Thorlabs ! For an available Thorlabs front panel please refer to 2.10.4. Not made to scale !

3 Service and Maintenance

3.1 General remarks

The ITC1xx laser controller module does not need any regular maintenance by the user. Only a possibly used ITC100D LED display should be recalibrated for highest accuracy.

3.2 ITC100D (re)-calibration

For higher display accuracy you should re-calibrate the ITC100D from time to time.
Calibration is carried out as "one point" calibration.
Refer to Figure 25 for potentiometer locations.

P1:	I_{PD}	P4:	T_{SET}
P2:	I_{LD}	P5:	T_{ACT}
P3:	I_{LIM}	P6:	I_{TLIM}

3.2.1 Adjust I_{PD}

Insert a known current from an external source into the photo current input. The current should be about 90% of full scale current.
Use P1 to adjust the display reading to the defined input current.

3.2.2 Adjust I_{LD}

Set your laser controller to constant current mode. Adjust the laser current limit to maximum current and the laser current setting to about 90% of maximum current.
Connect an Ampère meter to the laser output pins
Use P2 to adjust the ITC100D reading to the measured output current.

3.2.3 Adjust I_{LIM}

Set your laser controller to constant current mode. Adjust the laser current limit to about 90% of maximum current and the laser current setting to maximum current. Connect an Ampère meter to the laser output pins
Use P3 to adjust the ITC100D reading to the measured output current.

3.2.4 Adjust T_{ACT}

Bring your temperature sensor to a well defined temperature and adjust the ITC100D reading to that temperature using P5.

3.2.5 Adjust T_{SET}

Adjust your set temperature to about 90% of the full scale value. Turn on temperature control and wait until temperature has stabilized. Read the actual temperature $T_{ACT,}$ switch to T_{SET} and bring the reading in accordance with T_{ACT} using the potentiometer P4 (remember that T_{ACT} has to be calibrated first!).

3.2.6 Adjust I_{TLIM}

Connect an Ampère meter to the TEC current output. Adjust the TEC current limit to about 90% of full scale. Adjust the temperature setting to a much higher temperature and turn on temperature control.
Adjust the I_{TLIM} reading to the ammeter value using P6.

3.3 Troubleshooting

- <u>Unit does not work at all (no display):</u>

  - Controller connected properly to the external current source?
    - Connect the ITC1xx to a stable current source, take care of the right voltage setting (± 11.4... ± 15.8 V).

- <u>You don't get the desired laser output power</u>

  - Is the interlock closed?
    - Control the resistance between the interlock pins of the connector jack not to be more than 430 Ω.

    ➔ (refer to section 2.5.6, "Interlock and control LED for LASER ON " on page 37)

  - Do you have turned on the laser output?
    - Apply a "high" logical level to pin C15 of ST1 to turn on the laser output. The LED <u>"ON"</u> (LED 1a) on the pcb must be on

  - Is the hardware limit I_{LIM} set to 0 (P1)?
    - Adjust the hardware limit I_{LIM} by means of the potentiometer P1 on the pcb to the desired value.

  - Is the laser diode installed properly?
    - Control the connection cables.

  - Is the switch S2 set according to the laser diode polarity?
    - If not, change the S2.

  - Is the photo diode connected properly?
    - Check the connecting cable.

- Are you using a bias voltage with the photo diode in photocurrent mode?
  - Turn off bias voltage by interrupting the cable bridge or change the polarity of the diode for photo element mode.

  ➔ (refer to section 2.4, "Connecting the laser diode and photo diode" on page 26)

- Is the desired output power programmed correctly?
  - Turn to constant power mode (S1) and adjust the desired output power P_{LD} with the potentiometer P2.

- Is the ITC1xx running in temperature protection mode?
  - Check if the temperature window is set correctly.
  - Check if the laser temperature is out of window (laser is then switched off automatically).

◆ <u>You don’t get the desired operation temperature</u>

- Is the TEC connected properly to the connector?
  - Check all cables.
  - Check the correct polarity (see section 2.5.5 on page 36)

- Do you have turned on the temperature controller (high level on pin A13 of ST1)?
  - Apply a logical "high" level to pin A13.
  - The LED <u>“TEC ON”</u> (LED 1b) on the pcb must be on.

- Is the correct temperature sensor connected properly and is the temperature set accordingly ?
  - Check the corresponding connections and polarities of the temperature sensor (refer to chapters 2.5.1, 2.5.2 and 2.5.3, starting on page 33).
  - Adjust P4 to the desired temperature.

- Is the TEC current limit set to 0?
  - Adjust P3 to the desired TEC current limit.

- ➢ Do you have chosen the right temperature sensor?
  - Select the corresponding temperature sensor with S3.

◆ Set temperature differs from actual temperature (of the laser)

- ➢ Is the temperature not stable?
  - Adjust the corresponding PID-parameters carefully (refer to 2.7, "PID adjustment" on page 42)

If you don’t find the error source by means of the trouble shooting list please first connect the *Thorlabs Hotline (europe@thorlabs.com)* before sending the whole system for checkup and repair to *Thorlabs*.

(refer to section 4.5, “Addresses ” on page 59)

4 Listings

4.1 Warranty

Thorlabs warrants material and production of the ITC1xx modules for a period of 24 months starting with the date of shipment. During this warranty period *Thorlabs* will see to defaults by repair or by exchange if these are entitled to warranty.
For warranty repairs or service the unit must be sent back to *Thorlabs (Germany)* or to a place determined by *Thorlabs*. The customer will carry the shipping costs to *Thorlabs,* in case of warranty repairs *Thorlabs* will carry the shipping costs back to the customer.
If no warranty repair is applicable the customer also has to carry the costs for back shipment.
In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs warrants the hard- and software determined by *Thorlabs* for this unit to operate fault-free provided that they are handled according to our requirements. However, *Thorlabs* does not warrant a faulty free and uninterrupted operation of the unit, of the soft- or firmware for special applications nor this instruction manual to be error free. *Thorlabs* is not liable for consequential damages.

Restriction of warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient conditions stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. *Thorlabs* does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs reserves the right to change this operation manual or the technical data of the described unit at any time.

4.2 Certifications and compliances

Certifications and compliances

Category	Standards or description	
EC Declaration of Conformity - EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:	
	EN 61326	EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A Radiated and Conducted Emissions[1,2,3] and Immunity.[1,2,4]
	IEC 61000-4-2	Electrostatic Discharge Immunity (Performance criterion B)
	IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance criterion B) [5]
	IEC 61000-4-4	Electrical Fast Transient / Burst Immunity (Performance criterion B)
	IEC 61000-4-5	Power Line Surge Immunity (Performance criterion B)
	IEC 61000-4-6	Conducted RF Immunity (Performance criterion B)
	IEC 61000-4-11	Voltage Dips and Interruptions Immunity (Performance criterion B)
	EN 61000-3-2	AC Power Line Harmonic Emissions
Australia / New Zealand Declaration of Conformity - EMC	Complies with the Radiocommunications Act and demonstrated per EMC Emission standard[1,2,3]:	
	AS/NZS 2064	Industrial, Scientific, and Medical Equipment: 1992
FCC EMC Compliance	Emissions comply with the Class A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B[1,2,3].	

[1] Compliance demonstrated using high-quality shielded interface cables, including with CAB400 cable installed at the CONTROL OUT port and with CAB450 cable installed at the LD/TEC port.

[2] Compliance demonstrated with ITC100 series and DISP100 board modules installed in a Thorlabs PRO8000 mainframe unit (with PRO8000 display disabled).

[3] Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.

[4] Minimum Immunity Test requirement.

[5] MOD IN port capped at IEC 61000-4-3 test.

4.3 List of abbreviations

AC	Alternating Current
ADC	Analog to Digital Converter
AG	Anode Ground
CC	Constant Current
CG	Cathode Ground
CP	Constant Power
DAC	Digital to Analog Converter
D-Share	Differential share
DC	Direct Current
DIL	Dual In-line
DIN	Deutsche Industrie Norm
IC	Integrated Circuit
ILD	I (current) Laser Diode
IPD	I (current) Photo Diode
I-Share	Integral share
ITC	I (current) – Temperature Controller
JP	JumPer
LD	Laser Diode
LDC	Laser Diode Controller
LED	Light Emitting Diode
N.C.	Not Connected
PD	Photo Diode
PID	Proportional, Integral, Differential (regulator)
P-Share	Proportional share
SMB	Sub Miniature Connector typa "B"
TEC	ThermoElectric Cooler (Peltier Element)

4.4 List of figures

4.5 Addresses

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